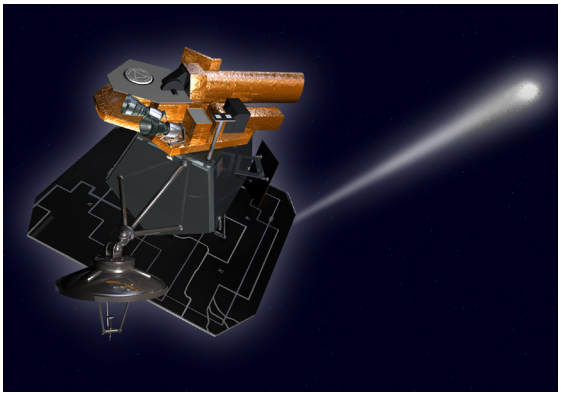
National Aeronautics and Space Administration

EPOXI Nears Comet Encounter

Until now, only four comets have been photographed close-up by spacecraft. Soon there will be five. The EPOXI mission, which is re-using the Deep Impact spacecraft, is on track for a close flyby of comet Hartley 2 on November 4.

On July 4, 2005, the Deep Impact mission sent an impactor into the path of comet Tempel 1 with spectacular results. Images of the impact show a tremendous flash of light and huge cloud of dust. After the impact, the larger "flyby" spacecraft, the one that released the impactor and captured those images, continued orbiting the Sun. In 2007, NASA funded a new two-part mission for the sturdy spacecraft.

This new mission, called EPOXI, first searched for extrasolar planets in 2008. Now it's about to give us a close look at another comet. For the bargain-basement cost of only $40 million, the space probe will fly to within about 620 miles of the small, half-mile-wide comet and add valuable new information to our body of knowledge about comets.



Artist's concept of EPOXI approaching comet Hartley 2.

Why re-use a spacecraft? Have you ever been in the market for an expensive item, maybe a new car? You might imagine all the fancy options you could add to your Dream Machine. But the high price could turn the dream into a nightmare. To be practical, you might just opt for a previously owned car that doesn't quite have all the bells and whistles you'd like, but delivers a good solid performance for a much lower price. Plus recycling is always a good thing to do. That's what NASA is doing by using the Deep Impact spacecraft and its science instruments for the EPOXI mission.

Two telescopes will closely observe surface features on comet Hartley 2, while the infrared spectrometer maps the composition of any outbursts of gas from the surface. A new mission might have chosen other instruments for different purposes, but for the low price tag compared to other space missions, EPOXI will deliver a tremendous amount of new information to help unlock the mysteries of our solar system.

On June 27, EPOXI flew past Earth at an altitude of about 19,000 miles for a "gravity-assist" to refine its final trajectory toward Hartley 2. Observations of the comet will begin on September 5, two months prior to closest approach, and continue through November 25, three weeks after closest approach. The science and operations teams are busy studying the planned observations at encounter to ensure that everything will execute properly and return the scientific results they are aiming for.

EPOXI's name is derived from its two science investigations — the Extrasolar Planet Observation and Characterization (EPOCh) and the Deep Impact Extended Investigation (DIXI), which is the upcoming comet encounter.

Education and Public Outreach Highlights

A new educational activity called "Comparing Comets" was recently added to the mission web site. In this activity, students play the role of cometary scientists, using images from the Stardust and Deep Impact spacecraft to study and compare the surfaces of two comet nuclei from close range.

EPOXI published their June–July newsletter, noting the five-year anniversary of the Deep Impact encounter with Tempel 1 and updating current mission status. The August newsletter featured images of comet Hartley 2 captured by participants in the Amateur Observers' Program.

INSIDE

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Stardust-NExT Getting Ready for Its Encore

Some of the Breakthrough Collaborative summer science teachers.

The Stardust-NExT mission is on its way to comet Tempel 1, in an unprecedented return visit to one of the few small bodies we've already had a close look at. In another example of recycling NASA-style, the thrifty mission will get lots of bang for the buck when the Stardust spacecraft returns to the scene of the Deep Impact mission's bold cratering experiment.

The upcoming February 2011 flyby will reveal the changes to the comet's surface since the 2005 encounter and its recent closest approach to the Sun. The spacecraft instruments will measure dust properties and compare them with the 2005 measurements and image features discovered previously, such as jets, layers and flow features. And if we're very fortunate, the size of the crater excavated by Deep Impact will finally be determined.

A Trajectory Correction Maneuver (TCM-29) on August 4 fired the engines for 38.2 seconds and provided approximately 0.7 m/s change in velocity to refine the path to Tempel 1. Other activities to prepare for the upcoming flyby include calibrating the navigation camera to assess the presence of background noise in images. The findings will assist in developing the command sequence for approach to the comet.

Education and Public Outreach

Stardust-NExT and EPOXI both participated in the month-long national Breakthrough Collaborative program in Denver, offering professional development to college students who are future educators. The training included five of the newest curriculum modules developed by the Stardust-NExT mission and two of EPOXI's signature comet activities. The college students then used their new resources to teach 175 middle school students about the solar system.

NASA/JPL Solar System Educator Erich Landstrom conducted a three-hour workshop for 30 middle school teachers called "Small Bodies — What's the Big Deal?" at the 34th Annual SECME (formerly the Southeastern Consortium for Minorities in Engineering) Summer Institute at Clemson University in Florida. The workshop highlighted the Stardust-NExT and EPOXI missions and their upcoming encounters.

The mission participated in Comet Activity Day for 58 Girl Scouts in grades 1–12 at Camp Mariposa in Altadena, CA. The scouts learned about comet modeling by doing the Comet-on-a-Stick activity.

Mercury Orbit Nearing for MESSENGER

As the MESSENGER spacecraft prepares for its upcoming Mercury Orbit Insertion in March 2011, it continues to add to the substantial body of information already collected.

Analysis of data from MESSENGER's third and final flyby of Mercury in September 2009 has revealed the first observations of emission from an ionized species in Mercury's exosphere, new information about magnetic substorms, and evidence of younger volcanism than previously recognized. The results are reported in three papers published online on July 15 in the Science Express section of Science magazine.

Mercury's exosphere is a tenuous atmosphere of atoms and ions derived from the planet's surface and from the solar wind. Observations of the exosphere provide a window into the extensive interactions between Mercury's surface and its space environment. The insights such observations provide into surface composition, transport of material about the planet, and loss of material to interplanetary space improve our understanding not only of the current state of Mercury but also of its evolution.

This image shows the Earth in the lower left, along with the smaller Moon to Earth's right. MESSENGER took this image from a distance of 114 million miles, slightly more than the distance from the Earth to the Sun. The photo was taken in May 2010 as part of MESSENGER's search for vulcanoids.

"Every time we've encountered Mercury, we've discovered new phenomena," said MESSENGER principal investigator Sean Solomon, of the Carnegie Institution of Washington. "We're learning that Mercury is an extremely dynamic planet, and it has been so throughout its history. Once MESSENGER has been safely inserted into orbit about Mercury next March, we'll be in for a terrific show."

The MESSENGER team is also making the most of the spacecraft's orbital position to conduct a search for vulcanoids. While flying at approximately 0.308 astronomical units from the Sun, or less than 30 million miles, MESSENGER has completed four campaigns on the lookout for these small asteroids that may orbit the Sun inside the orbit of Mercury.

Named after the hypothetical planet Vulcan, whose existence was disproven in 1915, vulcanoids may not even exist. None have been found yet, but they would be difficult to spot due to their small size, less than 37 miles in diameter, and the bright glare from the Sun.

"Our searches for vulcanoids may not turn up any objects," said Solomon, "but a discovery of even one vulcanoid would change our thinking about the evolution of Mercury. The solar system still has many surprises in store for us, so it makes sense for us to be ready for the unexpected."

Education and Public Outreach Highlights

The MESSENGER team selected 10 new members and 5 alternates to join the MESSENGER Educator Fellows Program. Twenty Fellows will continue with the program, for a total of 30. A training workshop for the Fellows took place in Washington DC in July. They learned about the mission from project scientists and engineers, received mission materials, and had many opportunities to interact with team members.

Each Fellow commits to conducting training workshops on the MESSENGER Education Modules to reach a minimum of 100 teachers per year. Over the 10-year program, more than 20,000 teachers will be trained, which can translate into classroom activities for more than one million students across the country.

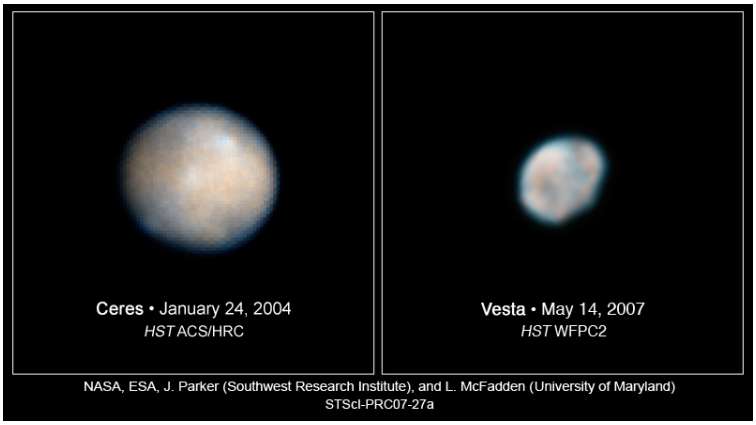
Dawn Prepares for Vesta Arrival

The Dawn mission recently accomplished a significant, but technical, feat. Soaring deep in the heart of the asteroid belt, the ion-propelled Dawn spacecraft eclipsed the record for velocity change produced by a spacecraft's engines.

NASA's Deep Space 1 spacecraft, also driven by ion propulsion, was the previous record holder. Dawn claimed the title on June 5, when its accumulated velocity over the mission exceeded 9,600 miles per hour.

A spacecraft's change in velocity refers to its ability to change its path through space by using its own rocket engines. This measurement of change begins only after the spacecraft exits the last stage of the launch vehicle that hurled it into space.

To get to where it is in both the record books and the asteroid belt, the Dawn spacecraft had to fire its three engines — one at a time — for a cumulative total of 620 days. In that time, it used less than 363 pounds of xenon propellant. Over the course of its eight-plus-year mission, Dawn's three ion engines are expected to accumulate 2,000 days of operation — 5.5 years of thrusting — for a total change in velocity of more than 24,000 miles per hour.



Dawn destinations.

Dawn's amazing ion-engine technology is what will allow it to be the first spacecraft to orbit and explore two bodies in one mission. Its 3-billion-mile odyssey brings it to asteroid Vesta in mid-2011 for a year-long orbit and then on to dwarf planet Ceres in 2015.

In preparation for arrival at Vesta, in June the Dawn team successfully loaded new software into the computer, providing key flight system capabilities needed to accomplish the goals of the science plan. In July they executed the first operational readiness test, simulating the ground processes and procedures, operational products, development timelines, and decision-making processes associated with the transition from the Vesta approach phase to the survey science phase.

Vesta and Ceres, the two most massive inhabitants of the asteroid belt, have remained intact throughout our solar system's history. By using the same set of instruments at two separate destinations, scientists can more accurately compare and contrast them. Dawn's science instrument suite will measure shape, surface topography and tectonic history, elemental and mineral composition, as well as seek out water-bearing minerals.

Education and Public Outreach Highlights

What do the Dawn mission and the Star Trek TV show have in common? And why is Captain Kirk barking orders at Dawn's chief engineer Marc Rayman instead of Enterprise chief engineer Scotty? Find the surprising answers here.

New Horizons Wakes Up and Works Out

On May 25, the New Horizons spacecraft once again was taken out of hibernation and put through a jam-packed nine weeks of testing and other activities for its fourth annual checkout, or ACO-4.

The first few weeks were devoted primarily to spacecraft activities, followed by almost three weeks of mainly payload-related activities and an encounter-mode test, which included examining the spacecraft's backup systems and re-calibrating the seven scientific instruments. A course correction was performed on June 30.

The summer's cruise science had the Ralph and LORRI instruments imaging Jupiter, Uranus, Neptune and Pluto, as well as some of their satellites. The heliospheric cruise science consisted of almost four weeks of SWAP and PEPSSI instrument observations of the space plasma (charged subatomic particle) environment in the region near the orbit of Uranus and some Alice instrument ultraviolet observations of the hydrogen and helium atoms that pervade the solar system. The checkout concluded with preparations for reentry into hibernation on July 30.

The mission's navigators determined the probe was slightly off course and found a rather obscure cause — a tiny thrust force from the soft reflection of thermal photons from the radioisotope thermoelectric generator (RTG) power source off the backside of the high-gain antenna. The effect is tiny but significant, with five more years of cruising to get to Pluto. To accomplish the needed course correction, the thrusters were fired for 35.6 seconds and sped the spacecraft up by about one mile per hour — just enough to make sure that New Horizons is on time for its planned closest approach 7,767 miles above Pluto at 7:49 a.m. EDT on July 14, 2015.

"So many systems have to work perfectly, together, for any spacecraft to take that amazing picture or collect any other data," says Alice Bowman, New Horizons mission operations manager at the Johns Hopkins University Applied Physics Laboratory in Laurel, MD.

Participants in the Nix-Hydra Workshop, held May 11–12 at the Space Telescope Science Institute in Baltimore.

"This summer we're validating the behind-the-scenes support and the spacecraft systems — from tracking to communications — that we'll use at Pluto in 2015."

Earlier in May, a workshop was held at the Space Telescope Science Institute in Baltimore to focus on Pluto's small moons Nix and Hydra, five years after they were discovered using the Hubble Space Telescope and five years before New Horizons will visit them.

Over the past five years scientists have mapped out their orbits, determined their colors, and constrained their diameters to be between about 25 and 90 miles. It has become clear that Nix and Hydra are somehow intimately related to Pluto's larger moon, Charon, as evidenced by their similarly circular and near-zero inclination orbits and their orbital periods, which are extremely close to being exact multiples of Charon's. The team is hoping for even better observations in 2011–2012 to obtain more precise information to assist in planning flyby observations.

Education and Public Outreach Highlights

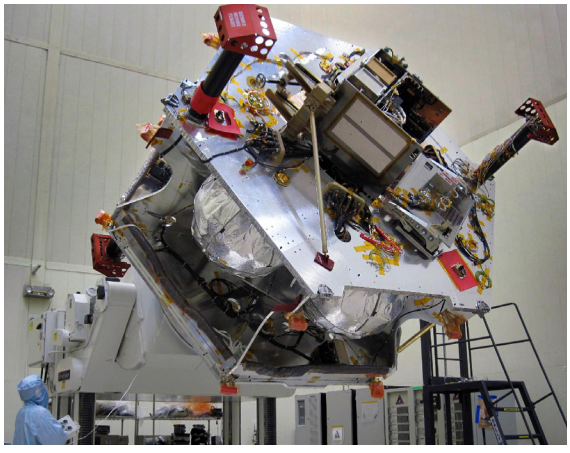
Watch the new video, "Halfway to Pluto: The Adventure Continues."

Juno Armored Up to Go to Jupiter

Since Juno's assembly, testing and launch operations, or ATLO, phase began in April, engineers and technicians have been fitting instruments and navigation equipment onto the rugged spacecraft.

To make sure the spacecraft is ready for the long journey to Jupiter and the harsh environment it will encounter there, engineers at Lockheed Martin Space Systems in Denver recently added a unique protective shield around its sensitive electronics.

The spacecraft will encounter a treacherous environment at Jupiter, with more radiation than any other place NASA has ever sent a spacecraft, except the Sun. "Juno is basically an armored tank going to Jupiter," said Scott Bolton, Juno's principal investigator, based at Southwest Research Institute in San Antonio, TX. "Without its protective shield, or radiation vault, Juno's brain would get fried on the very first pass near Jupiter."



Once the radiation vault was installed on top of the propulsion module, Juno was lifted onto a large rotation fixture, allowing it to be turned and providing easier access for integrating and testing instruments.

"For the 15 months Juno orbits Jupiter, the spacecraft will have to withstand the equivalent of more than 100 million dental X-rays," said Bill McAlpine, Juno's radiation control manager, at NASA's Jet Propulsion Laboratory in Pasadena, CA. "In the same way human beings need to protect their organs during an X-ray exam, we have to protect Juno's brain and heart."

The special radiation vault is made of titanium. It's not designed to provide complete protection, but will dramatically slow the aging effect radiation has on electronics for the duration of the mission. Juno isn't relying solely on the radiation vault, however. Scientists have designed a path that takes Juno around Jupiter's poles, spending as little time as possible in the sizzling radiation belts around the equator. Engineers also used designs for electronics already approved for the Martian radiation environment, which is harsher than Earth's, though not as harsh as Jupiter's.

The vault was lifted onto Juno's propulsion module on May 19. It will undergo further testing once the whole spacecraft is put together. The assembly and testing process, which also includes installing solar panels for the first-ever solar-powered mission to Jupiter, is expected to last through next spring. Juno is expected to launch in August 2011.

Juno will carry nine science instruments to investigate the existence of a solid planetary core, map Jupiter's intense magnetic field, measure the amount of water and ammonia in the deep atmosphere, and observe the planet's auroras.

Education and Public Outreach Highlights

The Juno mission was part of a two-day training in May offered by the Lunar and Planetary Institute's Explore! Library program. Twenty-eight librarians from rural Arkansas and Missouri, who provide programs for children ages 9–13, learned about Jupiter and the Juno mission by doing hands-on activities from Jupiter's Family Secrets, watching presentations by Juno scientists, and participating in group discussions.

“Space School Musical” Brings Fun to Science Learning

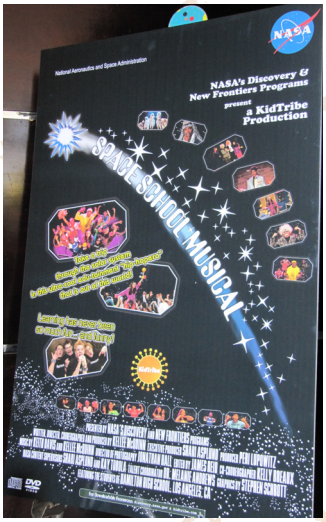
“Space School Musical” was unveiled at a red carpet premiere and DVD launch party held May 23 at the Level 3 nightclub in Hollywood. More than 250 attended, including the performers, their family members and friends, many JPL employees and their families, local teachers and afterschool educators. After watching the 30-minute video, guests were treated to a live performance of the planet song.

The musical is a creative collaboration between the Discovery and New Frontiers Program education and public outreach and KidTribe. It can be viewed and downloaded on the Discovery Program web site.

“Space School Musical” was also part of NASA’s Summer of Innovation kick-off festivities at the Jet Propulsion Laboratory on June 10. NASA Administrator Charles Bolden and 5 astronauts, along with JPL scientists and engineers, spoke to 250 Los Angeles–area middle school students who came to the Lab for the event. The students got to peer into the clean room where the next Mars rover, Curiosity, is being built, and they learned about NASA’s next mission to Mars, called Mars Science Lab.

The students then headed outside where they grabbed box lunches and sat on the lawn to watch live performances of “Planetary Posse” and “MoonDance.” Their field trip to JPL concluded with hands-on activities such as building and launching paper rockets and making comet models.

The Summer of Innovation is a multi-faceted program to engage thousands of middle school students in science, technology, engineering and mathematics (STEM) during the summer months when many students experience what’s known as the “summer slide,” a loss of skills acquired during the school year. The program is a cornerstone of the Educate to Innovate campaign announced by President Obama last November.



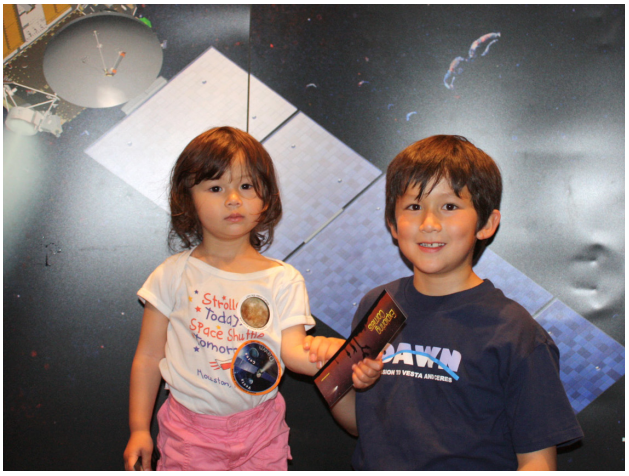
Scenes from JPL Open House

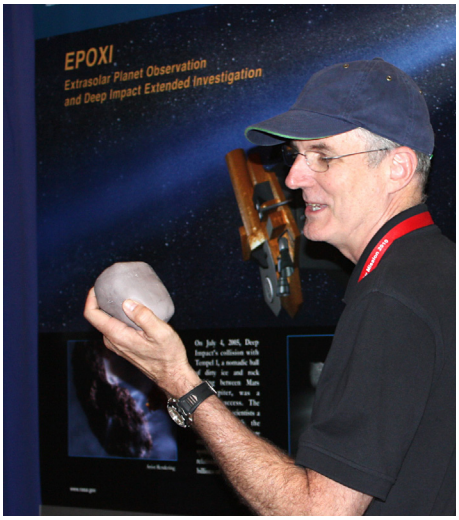
More than 36,000 science enthusiasts of all ages visited JPL's annual Open House, held on Saturday and Sunday, May 14–15.

All of the JPL-managed Discovery and New Frontiers missions had large, attractive displays in the Solar System area with models, videos, handouts, and much more. Project scientists, engineers, and educators were on hand to answer questions and explain what their mission is doing and why.

The Moon was featured with Moon Mineralogy Mapper and GRAIL. M3 staff shared hands-on activities, demonstrations with spectra, and lunar imagery. GRAIL brought 12 students affiliated with the Sally Ride Science Center, based at the University of California–San Diego, to staff their area, and talk about the mission and the MoonKAM education program.

Small bodies were well represented by Dawn, Stardust-NExT, and EPOXI. Juno joined the Outer Planets area, telling thousands of visitors about this upcoming mission during the two-day event.





GRAIL Assembly Begins

The Gravity Recovery and Interior Laboratory, or GRAIL, mission will send two spacecraft to orbit the Moon in tandem formation. The low-altitude, polar-orbiting twins will take precise gravity field measurements that will give scientists the information they need to determine the structure of the lunar interior from crust to core and understand the Moon's thermal evolution.

GRAIL will measure the gravity field of the Moon with unprecedented resolution, up to 1,000 times improvement over what we now have for the far side. The mission will also answer longstanding questions about our Moon and provide scientists with a better understanding of how Earth and other rocky planets in the solar system formed. Launch is planned for September 8, 2011, with orbit insertion on December 31, 2011.

This image was taken on June 29, 2010, during the propulsion subsystem assembly and integration effort in the Space Support Building clean room at Lockheed Martin Space Systems in Denver.

GRAIL's Systems Integration Review was conducted in June. The Standing Review board determined the project met all eight of the criteria with two liens. The board recommended the project proceed with ATLO (assembly, testing and launch operations) of the spacecraft with a review this fall prior to environmental tests.

In July, engineers conducted a fuel tank check on one of the GRAIL twins. They needed to confirm the size and fit of manufactured components prior to welding the fuel tanks into the propulsion system's feed lines.

Education and Public Outreach Highlights

Dr. Maria Zuber, the mission's Principal Investigator, gave a distinguished lecture at the University of Toronto on "Interiors of the Terrestrial Planets." She discussed expected results from the GRAIL mission.

Discovery and New Frontiers News

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